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BMDO Update

Linking American Businesses to Ballistic Missile Defense Technology

INSIDE

CMOS—The Future of Imaging *—by Jennifer Huergo*

BMDO-funded technology could change the way we view the world.

"Wish you were here" postcards could one day be a thing of the past because we will all be able to instantly send images from our vacations via cell phones. At least, this is the future according to the makers of complementary metal oxide semiconductor (CMOS) imagers. These imaging devices have already found their way into inexpensive digital cameras, including those for PCs and wristwatches, but are expected to one day account for an even larger portion of the $1 billion image sensor market.

CMOS imagers have begun making a dent in the market, accounting for 7.2 percent of all image sensors shipped in 1999, or 6.2 percent of revenues. Cahners In-Stat Group, a market analysis firm, projects that by 2004 the CMOS market-share will equal 50.8 percent of all sensors and 35.5 percent of revenues. One reason for the increased demand will be camera-enabled handsets, which some industry experts say could account for 20 to 50 percent of the global mobile phone market. The In-Stat Group is more conservative, predicting 17.8 million camera-enabled cell phones will be shipped in 2003, out of a total of 1 billion. That share could increase to 59.5 million in 2004.

Currently, lower manufacturing costs are helping CMOS imagers overtake older charge-coupled device (CCD) technology used in machine vision and security systems. Soon, new markets will open that exploit the small size and low-power needs of these sensors: possibilities include cell phone cameras, toys, safety devices in cars that let drivers see vehicles in their blind spots, and even medical devices that let doctors see what's inside their patients.

A New Role for CMOS Technology

CMOS imagers use the same technology found in ubiquitous CMOS microprocessors and application specific integrated circuits (ASICs). CMOS devices use *both* n-type and p-type transistors, as opposed to other semiconductor circuits, which use either n-type *or* p-type. The main advantage of these devices over their competition is that power is only dissipated when the circuit actually switches, resulting in significantly less overall power dissipation. This makes possible more CMOS gates on an integrated circuit and therefore much better performance.

MOS imagers first appeared in the late 1960s and paved the way for CMOS imagers. But they were overtaken by CCDs, which demonstrated superior dynamic range, lower fixed-pattern noise, and higher light sensitivity. Both CMOS imagers and CCDs rely on the same photovoltaic process to produce images, but on a CMOS chip, initial image processing is handled at each pixel. This architecture reduces the amount of light hitting the photosensitive region of the pixel, but it also reduces the amount of power needed to process and transfer the electrons created by the incident photons. A CCD's use

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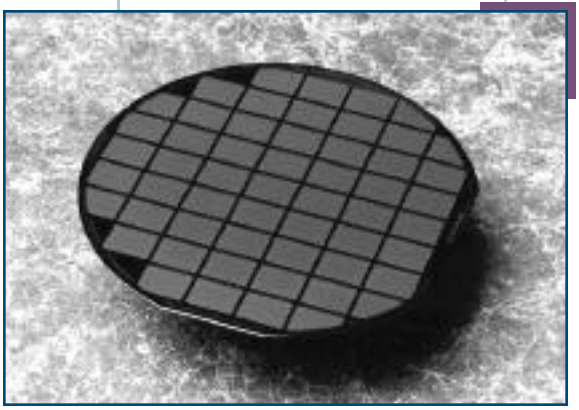

Simplified circuitry. *Amain's CMOS sensors digitize detector signals at the pixel, saving precious chip space. About 73 percent of the active pixel area remains for photon collection.*

FEATURE

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of a single processor at the chip's edge draws significantly more power. The spread of CMOS technology and improvements to it, such as submicron lithography and advanced signal-processing algorithms, have also benefitted CMOS imagers to make them smaller, faster, and cheaper than CCDs.

Meanwhile, the inexpensive infrared (IR) and ultraviolet image-sensing capabilities of CMOS imagers have captured the attention of BMDO. The low-cost imagers could be used in missile tracking, satellite navigation systems, or for machine vision in manufacturing. By supporting research into CMOS imaging, BMDO is helping to establish an industry base from which it will eventually draw talent and obtain low-cost products.

Let in the light. *Trex's Hi-Sight technology applies a surface coating to CMOS imaging chips that helps these devices achieve fill factors 60 percent higher than competing devices.*

CMOS Technology Faces Challenges

The development of novel CCD technology continues. Therefore, CMOS imager manufacturers will have to be aggressive and address several areas of concern if they want to truly challenge CCDs in high-end uses such as medical and military applications. One challenge CMOS imagers must overcome is a tendency toward low fill factors. Fill factor refers to the percentage of pixel area that is devoted to light collection, which on a CMOS chip is reduced because of the at-pixel processors. Applying a microlens coating to the chip's surface is one method of increasing the chip's light collection, but CCDs still dominate in terms of fill factor.

Processing speed is also an obstacle because unlike CCDs, CMOS imagers do not send data to a processor one line at a time. An image is taken by turning on and off many thousands or millions of pixels at once, creating a tremendous amount of data that must be further processed and sent to a display. Improving dynamic range, or the ability to image scenes of high contrast, is also a problem. While even CCDs have trouble with scenes of high contrast, the problem is worse for CMOS imagers. Some imagers address this problem by changing exposure lengths between images, but things change image to image, so an object lurking in the shadows may be gone before the next image is shot.

Three BMDO-funded companies are addressing these issues and leading the development of new CMOS imager technology.

Fill Factor Fix

Trex Enterprises Corporation (Kihei, HI) has found a way to improve the fill factor and quantum efficiencies of CMOS imagers, while increasing the number of pixels-per-wafer to reduce costs. Through a patented process called Hi-Sight™, Trex applies a photosensitive coating to the top surface of a CMOS image sensor. The thin film absorbs light, and charges are generated and passed down vertically to an amplifier circuit. The photoconductor diodes that perform the light conversion do not share the CMOS substrate with the amplifier circuitry and logic, so the entire area can be devoted to light collection. Hi-Sight makes possible fill factors over 90 percent and quantum efficiencies over 80 percent, compared with other CMOS imagers, which have fill factors as low as 30 percent and peak at about 70 percent only with microlenses. The Trex CMOS imagers can rival the light-collecting capabilities of back-thinned CCDs, but with lower power needs, higher pixel counts, and simpler manufacturing.

The original patented technology was developed with BMDO funding as a way to replace x-ray film with selenium-coated CMOS imagers. Trex then developed the photoconductor film for visible light and used it in CMOS image sensor circuits, including a 1920 x 1080-pixel high definition TV format device. This device, which Trex plans to market, has 5-micron pixels and a 30-Hz frame rate. The company has also developed a 640 x 480-pixel tethered video camera for PCs and is working on designs for a cell phone imager and very high resolution (greater than 50 megapixels) sensor.

By changing the coating material, it is possible that Trex's sensors will be useful for wavelengths outside the visible range. BMDO is interested in UV sensors for the detection and tracking of missile plumes.

Faster Image Processing

Amain Electronics Company, Inc. (Simi Valley, CA), is not only looking to improve

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FEATURE

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CMOS imaging for video, but to change the way we create and view video images. Amain's BMDO SBIR-funded innovations are based on a signal processing technique common to audio systems, called oversample analog-to-digital (OSAD) conversion. It essentially trades a higher sampling frequency for processor simplicity.

With Amain's version of OSAD, called MOSAD (the "M" stands for multiplexed), detector signals are digitized at each pixel, eliminating circuit elements that add size, weight, and cost. The early conversion of the analog signal to a digital one decreases the signal's susceptibility to noise and increases processing throughput. This circuitry takes up less space than on conventional CMOS imagers, with 73 percent of the active pixel area devoted to photon collection, thereby eliminating the need for a microlens or coating to improve collection efficiencies.

In addition, with this process there is no need for rastering, a computer's way of mimicking frame sequencing (in which one image frame follows another). That familiar but dated (it's been around since the 1890s) method of presenting images is great for film, but totally unnecessary for digital imaging. Today's non-raster display systems, such as liquid crystal, plasma, and field emission, use x-y addressing schemes that can directly play back the converted digital stream. Amain is offering a new display technology, Stream Vision, that does not suffer from flicker and provides high dynamic range display. Stream Vision's IR or visual imaging applications include video conferencing, security monitoring, and machine vision.

The BMDO-funded sensor research that eventually led to Amain's new technology was for an all-digital imager that would use less power, be smaller, and weigh less than current analog devices.

Dynamic Range Improved

The human eye has an, as yet, unexplained ability to process scenes of high contrast: for example, you can watch the setting sun's bright reflection on the sea and still make out the boat sitting in the water beside it. Visible light imagers, however, have a great deal of difficulty handling such extremes. The best CCDs can handle variations of about 60 to 70 dB (dB being a relative scale used here to describe degrees of contrast) and CMOS imagers 70 to 80 dB.

With BMDO SBIR funding, Photobit Corporation (Pasadena, CA) is developing a CMOS imager that can conquer scenes with contrast variations as great as 108 dB. To achieve this range, Photobit has developed a novel sensor architecture that simultaneously captures light at four different sensitivity levels. This technique is an alternative to taking several sequential images at different exposures, which introduces blur into the final image, and to a logarithmic response, which reduces the image contrast.

Photobit's new imager works with a real-time fusion and dynamic range compression algorithm that generates a high-dynamic range image from the four images of different sensitivity—for display at a video rate of 60 frames per second. The sensor is fabricated through standard CMOS processing and so it preserves the attractive low-cost quality of CMOS technology. By simplifying the design for high dynamic range imaging, Photobit's imager could be affordable enough to find its way into driving aids that will give us a view of what have been our vehicles' blind spots.

For BMDO uses, Photobit's imager could provide satellite star tracking, or even tracking of objects down here on Earth.

Blind spot. *A bright light shone directly on a conventional high sensitivity sensor overwhelms the device (top). But Photobit's very high contrast CMOS sensor registers nearby objects clearly (bottom).*

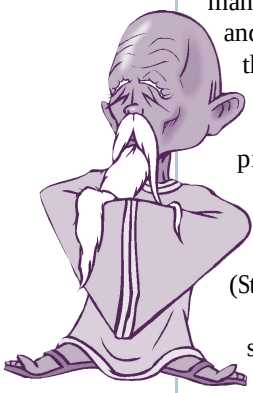
The Future of CMOS

The advantages of CMOS imagers over other technologies will allow them to continue expanding their reach into the imaging market. Not only could this change our postcard-writing habits, but it could bring speed and efficiency to the workplace for insurance adjusters, real estate agents, and many others. The technology advances being made at companies such as the three mentioned here will also allow CMOS imagers to enter high-end markets such as biometrics or medical devices. It may seem an exaggeration to say that CMOS imagers will one day be everywhere, but considering a recent medical experiment in which a Photobit CMOS device returned images of a man's intestinal tract, perhaps it's not.

☑ Contact Paul Johnson of Trex Enterprises at (808) 875-2610, William Mandl of Amain Electronics at (805) 577-0583, and Sayed Eid of Photobit Corporation at (626) 683-2200. Or, on the reader request card, check 3301 for Trex, 3302 for Amain, and 3303 for Photobit.

WORDS FROM THE WISE

IMPROVING YOUR CHANCES FOR SBIR SUCCESS



Plato, the ancient Greek philosopher once said, "A wise man learns from experience and an even wiser man from the experience of others." If you are planning to propose or are already proposing SBIR-funded research, you may be interested in what Sterling Semiconductor, Inc. (Sterling, VA), has to say.

Sterling has received several SBIR contracts from BMDO and other Federal agencies to develop and refine its silicon carbide technology. The company has been acquired by Uniroyal Technology Corporation and is currently undergoing a major expansion of its production capabilities. With these early accomplishments complete, it has learned many lessons for small business success. Here is Sterling's top ten list of helpful tips for proposing and conducting SBIR-funded research.

10. *Have a non-employee review your SBIR proposal.* This independent person should have experience with SBIRs and act as a "coach" during the development of the proposal.

9. *Center your business plan on shipping product to customers.* By supporting this plan with SBIR funding, you will impress upon both the government SBIR reviewers and potential Phase II Fast Track investors that your purpose is to achieve commercial success.

8. *Know the government SBIR program managers and their objectives.* It helps you understand the context of SBIR government proposal solicitations and the longer-term program goals of the funding agency.

7. *Anticipate that university subcontractors won't act like commercial companies.* Professors and students have their own schedules, and deadlines need to be established accordingly.

6. *Submit proposals that offer some "pizzazz," a technological stretch, or a "first."* Get the reader excited! But don't propose the perpetual motion machine.

5. *Use a lead investigator who is known to SBIR program managers and qualified in the field.* It's easier for proposal reviewers to buy into the proposal if they have confidence in the lead investigator.

4. *Get accounting help from someone on staff (or an outside accountant) who is familiar with SBIR programs to assist with preparing the "numbers" part of the proposal.* If awarded, expect an audit.

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CEO SEARCH: HOW ONE SBIR COMPANY DID IT

It's not easy to hire someone to run the family business. Or is it? In 2000, as privately owned Metal Matrix Cast Composites, Inc. (MMCC; Waltham, MA), sought outside financing, founder James Cornie embraced the idea of hiring a professional chief executive to take the materials developer to the next level. "I realized that while I was probably a damn good scientist, I didn't have the formal business training needed to secure additional resources, let alone run a business," recalls Cornie, whose company now has more than 20 employees. "So we started an informal search and our first candidate turned out to be a friend of a friend."

Meanwhile, Robin Brumwell, a seasoned financial executive with accounting and management experience, had just retired from a senior vice president position at a metals manufacturer. After hearing about the opportunity through a friend, Brumwell quickly hopped up from the hammock to meet with Cornie and his long-time partner. The two groups tested one another's visions, goals, and philosophies at their first meeting. Each felt good about the other so they agreed to dive deeper into the process. Cornie checked about a dozen references and had Brumwell meet with MMCC's accountant and lawyer to discuss the company's financial health and negotiate a performance-based employment contract. He was hired soon after.

As chief technology officer, Cornie is now spending more of his precious time developing MMCC's technology. He still retains control over his company, as chairman of the board, but the day-to-day operations are now the responsibility of the new CEO. Brumwell is busy, too. He is responsible for guiding the company from pilot plant production to full commercialization, locating outside financing, recruiting professional management, and installing new production equipment. "On top of that," Brumwell adds, "there's only a million and one other things for me to do."

HEADS UP

NEW WEB SITE LAUNCHED FOR TECHNOLOGY SCOUTS

Lots of folks, including technology scouts, like to find innovative technology that could be used in their company's R&D efforts. Until now, that's been a costly proposition. The BMDO Technology Applications (TA) program has recently launched a new Web site that helps locate maturing BMDO innovations with commercial potential—for free.

The site, www.bmdotechnology.net, enables users to search and view a growing number of abstracts of BMDO-developed technology. Along with a description of the technology, each technology abstract contains information about its BMDO application, its potential commercial applications, and the developer's commercialization efforts. A profile of the developer is also included.

More information about each technology is only a hyperlink click away, as the developer's e-mail and Web site addresses are provided at the end of the abstract. For users who want to contact the developer by more conventional means, the abstract also includes the developer's facsimile and telephone numbers and mailing address.

CORRECTION:

In the Winter 2000/2001 *BMDO Update*, we mistakenly reported PointServe's telephone number as (512) 472-5300. The correct number is (512) 617-5300.

"We are excited to share the innovations and breakthroughs that BMDO-funded technology is making," says Paul Koskey, director of the TA program. This technology can increase the utility, reliability, versatility, and competitiveness of the new generation of products that will serve all consumers."

"BMDOtechnology.net is an invitation to all technology scouts and aficionados tracking the cutting edge of science," Koskey adds. "The site is intended to provide easy access to information and contacts that could make a real difference in the R&D programs of companies and individuals working to bring new products and services to market. Ultimately, it will enrich our national technology resources for commercial and defense components and systems."

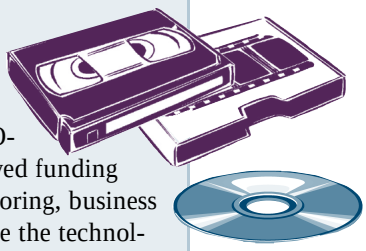
Other interesting site features include:

- *Simple search engine.* Searching for technology is quite easy, only requiring the user to type in a keyword or two and press the "Go" button. Or, the user can click on a hyperlink that shows all the abstracts on the database.

- *Current news stories.* A spider program searches the World Wide Web each day for news that relates only to BMDO-funded developers and their technologies. Hyperlinks allow users to read these stories.

- *Automated e-mail notifications.* Using an automated e-mail message capability, the site can notify users when new abstracts relating to their technology areas of interests are added to the database.

VIDEO/CD EXPLAINS ALL TO BMDO-FUNDED ENTREPRENEURS



Attention BMDO-funded researchers: Many of you may not be aware of the commercialization services available to you free-of-charge through the BMDO Technology Applications program. All BMDO-funded researchers—even those who have not received funding from our agency for years—have free access to mentoring, business development, and outreach services to commercialize the technology and products that have resulted from BMDO-funded research. Whether you are an early stage developer or already have a prototype, these services can help you develop strategic partnerships, define a business strategy, obtain needed guidance from experts with records of success, and attract capital to scale up your technology for commercial and defense use.

BMDO just released a new video/CD that explains its commercialization review and outreach services. Take a look. Your ultimate success in scaling up your technology is likewise BMDO's success for your technology's use in future acquisition programs.

☑ For a free copy of the video/CD, check 3304 for the video *OR* check 3305 for the CD on the reader request card.

ADVANCED MATERIALS

SMALL BIZ SCALES UP MATERIALS PROCESS FOR MEDICAL AND DEFENSE USE

While applications for medical "CAT" scanners and missile control systems are miles apart, they share the same technology need: advanced materials that can withstand thermal shock. Advanced Ceramics Research, Inc. (ACR; Tucson, AZ), is capitalizing on this requirement, scaling up a "fibrous monolith" process that fabricates complex composite parts using low-cost powders and polymers. This process creates an interpenetrating microstructure, making the material tough and resistant to thermal shock.

ACR began this work under a BMDO SBIR contract, obtaining co-investment from both Thiokol and Varian.

Under contract to Thiokol, the small business is applying hafnium carbide (HfC)/tungsten-rhenium to carbon diverter valves for propulsion applications. The approach should cost much less, while performing up to or better than specifications.

With Varian, ACR plans to develop and sell x-ray targets used in Computer-Aided Tomography (CAT) scan x-ray tubes, aiming to make ceramic composite HfC/tungsten-rhenium x-ray targets that cost less than the current tungsten ones, while withstanding higher temperatures and resisting thermal shock better. In this way, cycling time is reduced, allowing more CAT scans per day. The commercialization path in the medical arena will ultimately allow ACR to scale up its processing capabilities so that defense programs, including BMDO's, can use the materials on a larger scale at a lower cost.

☑ Contact David Blanchard of ACR at (520) 573-6300 or check 3306 on the reader request card.

SMART CONTROL SYSTEM REDUCES VIBRATIONS

Imagine wallpaper that can tailor the acoustics of a room at the snap of a switch, or an airplane whose skin has noise control, self-diagnostics, and self-repair capabilities. Quality Research, Development & Consulting, Inc. (QRDC; Chaska, MN), has developed a material and smart-control system that dampens vibration and acoustic energy by actively channeling energy flow to strategically placed energy-sinks. The Energy-Based Smart Skin Structure™ (EBS^3), or smart skin, could control vibration and noise on anything from home appliances and aircraft to automobiles and offshore oil-platforms.

EBS^3 is based on earlier DARPA-funded work on a patented QRDC technology called Vibration Control by Confinement™ (VCC), which suppresses noise and vibrations by controlling energy flow with embedded actuators and sensors. VCC demonstrates a 90 to 98 percent improvement over passive dampening techniques—such as dampers, isolators, and absorbers—and will be much more efficient than other newly developed active dampening technologies as well. While VCC technology is retrofitted on existing materials, EBS^3 improves on VCC technology by embedding sensors and actuators into a new multi-layer composite. A prototype of the skin is 0.25 in. thick, and should easily shrink to about a millimeter in future prototypes (and with more far-reaching plans to someday make micro- and nanometer-scale skins). QRDC, which received BMDO SBIR funding for EBS^3 to protect sensitive instruments from vibration, has founded a separate company, Smart Skin, Inc. (SSI), to exclusively market EBS^3-based products. The company is investigating possible markets and hopes to begin commercial production sometime between 2001 and 2003. SSI is now seeking investments from interested parties.

☑ Contact Dan Woodbury of QRDC at (952) 556-5205 or check 3307 on the reader request card.

Courtesy of Boeing

Flex form. *With BMDO SBIR funding, QRDC has developed a "smart material" that can adjust itself to changing aerodynamic conditions. This capability may improve the fuel efficiency of commercial and military aircraft.*

"There ain't no rules around here. We're trying to accomplish something!"

—Thomas Edison

L-O-L IN NOISY SETTINGS?

Will you be checking your e-mail on the interstate? Access to the Internet inside consumer vehicles beckons a tremendous worldwide market, offering the availability of whole new product lines and services for automotive manufacturers. However, it is mired by safety issues because drivers simply do not have enough hands or eyes to "e-drive." Clarity, LLC, is marketing an enabling technology for speech recognition called Clear Voice Capture (CVC)™ that addresses these safety issues, as well as the size, performance, and cost needs of the automotive industry. The company recently sold its first product to a major electronics producer in September 2000.

CVC performs significantly better than conventional speech recognition microphones since it works by extracting the voice signal of interest from a mixture of sounds rather than suppressing noise, which can sometimes result in a suppressed signal as well. Demonstrated in an automobile in a variety of conditions, CVC improved the accuracy of speech recognition by 35 to 40 percent as compared to conventional systems. It also costs less than half as much as its main competition, array microphones ($5 to $45 as opposed to $100) and only occupies 1.5 by 0.5 in. of surface (as opposed to 5 to 10 in. for array microphones). Such feature benefits also translate well to other applications in other noisy settings such as handheld devices and cellular phones.

Based on time domain signal extraction techniques, CVC uses two microphones and advanced algorithms to mimic the human ear and brain. The algorithms exploit statistical properties of distinct sound sources to isolate the voice signal of interest from background noise. The end result is speech that can be better understood in a noisy background, without the need for headsets that tether and encumber the user. This technology was developed under a BMDO Phase II *FasTrack* project at IC Tech, Inc. (Okemos, MI), to increase the robustness and sophistication of battle management, command, control, and communications systems. IC Tech licensed the technology to Clarity last year after forming a limited liability corporation with support from venture capital. Clarity welcomes inquiries about CVC related to automotive, industrial, and other applications.

☑ Contact Dr. Gail Erten of IC Tech at (517) 349-9000 or check 3308 on the reader request card.

Clarity's CVC technology improves the accuracy of speech recognition by 35 to 40 percent.

TRACKING SYSTEM SPEEDS UP POWER LINE INSPECTION

Using sophisticated technology to track something that doesn't move may sound like a waste of time, but it could be a significant time-saver for monitoring power transmission lines. Currently, the lines are inspected by technicians in vehicles and on foot—a time-consuming task considering the hundreds of miles of line they must cover. To speed up this process, SVS Inc. (Albuquerque, NM), has developed a helicopter-mounted monitoring system that relies on advanced tracking technology. INSPECT automatically keeps transmission lines centered in a camera's field of view despite the helicopter's motion and the rise and fall of the lines between support towers and over uneven terrain.

Courtesy of DOE

Time flies. *The time needed to inspect hundreds of miles of power transmission lines could be significantly reduced using an automated helicopter-mounted monitoring system from Boeing-SVS.*

An integrated system of commercial hardware and SVS's unique software tracks the power lines and provides time-tags and geo-references for the collected data. Back on the ground, the recorded images are reviewed by additional SVS software, which marks potential problem areas such as damaged equipment or overgrown vegetation. The automated analysis again speeds up the inspection process by saving employees from reviewing every inch of video. INSPECT incorporates the same precision technology found in SVS's Opti-Trak™ systems, used mainly for missile and satellite tracking. The technology was originally developed for BMDO's Low Cost Space Structures project, in which the system tracked laser dots on space structures to align optics. SVS, recently acquired by Boeing Company, is looking for utility providers that need a fast and accurate way to monitor their power transmission lines.

☑ Contact Dave DeYoung of Boeing-SVS at (505) 449-4600 or check 3309 on the reader request card.

ELECTRONICS

NEW PATTERNING TECHNOLOGY MAKES FASTER ELECTRONICS, SHARPER DISPLAYS

Attention microelectronics manufacturers: Frustrated by the limited size of substrates that lithography systems can handle or by the slow throughputs of large area patterning systems? If so, take a good look at the product line of the small but rapidly growing Anvik Corporation (Hawthorne, NY). With the help of BMDO SBIR-funded research, Anvik has developed a line of large-area excimer-laser patterning systems that offers higher resolution and higher throughput than other units now used—at a fraction of the price.

Affordable lithography. *Anvik's microelectronics patterning systems offer higher resolution and higher throughput than competing systems—at a fraction of the cost.*

By placing the lithography mask on the same planar stage as the substrate, Anvik's system design allows the mask and substrate to scan in unison, thereby eliminating the difficult and costly synchronization of separate stages. In addition, Anvik's hexagonal scanning technique eliminates the stitching errors that plague conventional projection and step-and-repeat imaging techniques. This capability allows substrates as large as 24 x 24 in. (610 x 610 mm) with a variety of thicknesses and flexibilities that are seamlessly produced at uniform exposure. Minimum image resolutions as low as 0.5 to 0.7 microns are possible at a throughput rate as high as 240 12 x 12-in. (305 x 305 mm) panels per hour. Anvik's simplified design is more affordable as well: Systems cost between $600,000 and $1.5 million, as compared to $5 to $7 million for traditional stepper units.

Anvik's patterning systems can pattern lithographic features and form vias for production of a variety of electronic devices, such as flat-panel displays, multichip modules, printed circuit boards, and microelectromechanical systems. They can be used in a variety of fields. Circuitry manufacturer Sheldahl, Inc., has acquired an Anvik system to manufacture flexible circuits for cell phone and automotive applications. And, the Swedish industrial research company ACREO is developing the next generation of large-area optoelectronic modules for high-speed communication applications with an Anvik system. Anvik Corporation welcomes sales inquiries from interested companies.

☑ Contact Marc Zemel of Anvik Corporation at (914) 345-2442 or check 3310 on the reader request card.

PASTE COMPOSITION TAKES ON EPOXIES

Aguila Technologies, Inc. (San Marcos, CA), has created a new epoxy paste hybrid for electronics packaging that could inexpensively allow silicon semiconductors to withstand harsh environments such as extreme hot or cold, moisture, and other contaminants. Compared to conventional epoxies, this paste is a much more durable and effective encapsulant (for example, it has a decomposition temperature of 350ºC, compared to 180 to 200ºC for conventional epoxies). It also absorbs less moisture than typical epoxies and is easier to work with during processing. The paste is formed without solvents and it can be applied to semiconductor chips or wafers by screen printing to replace the typical underfill encapsulants. The process is environmentally friendly (epoxy solvents are typically bad for the environment) and allows the application of thicker layers in one step, which reduces processing. Development of the paste was funded by BMDO for protecting electronics in harsh environments. For example, BMDO has electronics that stand idle for 20 years, and then must operate on cue in a completely different environment.

Commercial interests also stand to benefit from Aguila's research. Aguila is collaborating with one automotive electronics component manufacturer to use the paste composition as the underfill encapsulant for flip chips used in anti-lock brake systems. Another electronics component manufacturer may use Aguila's paste as an encapsulant for a ball-grid array device used in engines and transmission controllers. Both of these applications require a material that can withstand the harsh conditions found near automobile engines. Aguila is also using the material for memory module packaging. It will allow Aguila to pack more memory chips into a smaller card while also increasing card access speed. The company is looking for partners to help finance expansion of the memory card manufacturing business, and the technology is also available for license.

☑ Contact M. Albert Capote of Aguila Technologies at (760) 752-1192 or check 3311 on the reader request card.

ELECTRONICS

PERFECT PICTURES COME FROM LESS-THAN-PERFECT CCDs

Medical diagnostics require perfect images from charge-coupled devices (CCDs) to give doctors the most accurate view of human tissue. But perfection never comes cheap. Fighting wafer imperfections and other manufacturing problems drives the cost of CCD-dependent devices out of the range of many small hospitals. Fortunately, BMDO's pursuit of low-cost sensing technology has led to a new imager that could drastically reduce the costs of important medical devices. With funding from an SBIR contract, Silicon Mountain Design, Inc. (SMD; Colorado Springs, CO), has developed a way to use inexpensive, less-than-perfect chips to take perfect images.

The concept is simple and effective: SMD designed a new camera that works around an imaging chip's defects, including point, cluster, or column defects, by slightly shifting the chip between sequential exposures. The chip's defects are first mapped and measured to ensure none are larger than 50 microns. After a single exposure, the chip is shifted 50 microns along the x-y axis for a second image. Information missing from one image is filled in with the data from the second to create a "perfect" image despite the chip's imperfections.

The price reduction is drastic—a defect-free 2,000 x 2,000-pixel CCD costing about $8,000 could be replaced with a $3,000 chip of the same dimensions but with a few defects. For larger CCDs, the replacement could reduce the cost of a $500,000 medical diagnostic tool to about $50,000. SMD was recently acquired by DALSA Corporation, which is looking to incorporate the SMD camera into medical diagnostic and research equipment, including DNA sequencing and gene therapy devices.

☑ Contact Ralf Brooks of DALSA at (519) 886-6001, extention 2186, or check 3312 on the reader request card.

SMD's camera technology creates "flawless" imagery from flawed chips.

ALTERNATE SUBSTRATE DEVELOPED FOR GaN ELECTRONICS

With applications such as higher capacity CD-ROMs using blue lasers and electronics that operate at high temperatures, gallium nitride (GaN) semiconductors have attracted considerable commercial interest recently. However, a major commercial barrier to commercializing GaN-based devices is the inability to economically grow high-quality GaN-based substrates, upon which the thin epitaxial layers of active GaN electronics are grown to form a semiconductor device.

Crystal IS, Inc. (Latham, NY), believes it is close to perfecting the next best thing to a GaN substrate. The company has developed a competitively priced aluminum nitride (AlN) substrate that will offer high thermal conductivity and low thermal expansion mismatch with GaN. These properties virtually eliminate the cracks that form between epitaxial GaN and today's substrates (either sapphire or silicon carbide) during the temperature shift from epitaxial growth to room temperature.

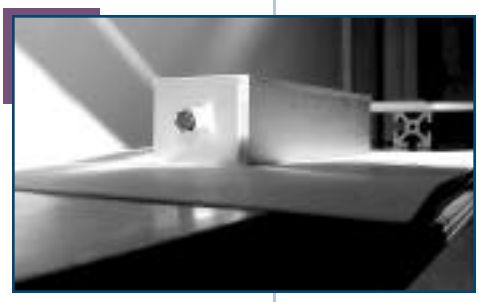
Crystal IS is producing AlN substrates up to 15 mm in diameter and should be able to reach 25 mm soon. In addition, the company believes it can grow the substrate to 50 mm (2 in.), the industry standard, by the middle of next year. While AlN will allow semiconductors to operate in the high-temperature environment of an anti-missile interceptor, it could also be used in commercial applications, such as high-power switches for electricity grids, super-efficient room lighting with white light-emitting diodes, or higher capacity CD-ROMs and DVD players using blue lasers. Crystal IS has sold small amounts of AlN substrates for military applications, and is looking for a partner to help the company scale up and fund a pilot production facility to attract commercial interest.

☑ Contact Leo Schowalter of Crystal IS at (518) 783-0863 or check 3313 on the reader request card.

Nice price. *Crystal IS has competitively priced its 15-mm AlN substrate to attract economy-minded semiconductor manufacturers growing high-quality GaN substrates.*

FIBER OPTICS

SIGNAL PROCESSING SYSTEM MAKES FINER MEASUREMENTS



Going the distance. *Brimrose's photodetector will push the performance boundaries of optical interferometers to their theoretical limits.*

Testing newly manufactured fiber-optic lines for chromatic and polarization dispersion is expensive and inefficient. Since dispersion is so small, a test fiber as much as a kilometer long is needed to get an accurate measurement from a sample signal. One day soon, however, dispersion tests on centimeter-length fibers may be possible. Brimrose Corporation of America (Baltimore, MD) is developing a novel photodetector that, when used in a dispersion-testing package, can make dramatic gains in the signal resolution. In fact, Brimrose's technology, when used in other techniques of optical measurement, can improve spatial resolution by more than two orders of magnitude.

Brimrose's signal processing technology improves spatial resolution by overcoming the fundamental resolution limits of time delay measurements and interferometry, two common techniques of measuring distances. The "photoelectromotive-force" detector produces an output voltage proportional to the frequency difference between two laser signals. With this detector, Brimrose implemented a microwave radar signal processing technique called coherence frequency domain reflectometry (CFDR) to the optical spectrum, eliminating the mathematical processing that slows signal analysis.

Though BMDO originally funded this SBIR research to shrink the size of its Doppler radar units, this technology can be employed in an imaging system that would be of use to makers of optics equipment, data storage equipment, integrated circuits, semiconductors, thin-film coatings, and maintenance management equipment. Brimrose is currently seeking outside financing to convert this technology into new measurement products. In addition, the company welcomes inquiries regarding other applications of the technology, such as improving the resolution of Doppler radar and other imaging techniques such as ultrasound, sonar, and laser radar.

☑ Contact Chen Chia Wang of Brimrose Corporation at (410) 668-5800 or check 3314 on the reader request card.

ROBUST PHOTONIC SWITCH ON THE WAY

RPI will begin commercial production of its robust photonic switch by this summer.

In the heated race to build an optical-core photonic switch for the hungry telecommunications market, Radiant Photonics, Inc. (RPI; Austin, TX), may have the inside track. The company has developed a more versatile and robust switch than competing photonic models, thanks to use of electro-optic polymers developed in part from BMDO SBIR research. These proprietary electro-optic polymers form an electro-optic prism that varies its index of refraction in response to input voltage, allowing the device to route signals along certain paths. RPI's switch is insensitive to polarization differences or slight wavelength variations, eliminating the need for more expensive lasers and related correcting equipment that other polymer-based switching technologies would require. The device performs equally well over all currently used communications bands (C, L, and S bands), can provide faster switching speeds (up to 1 nanosecond vs. 4 milliseconds for other proposed optical-core switches), and features low insertion losses (less than 1 decibel). The interconnect may be designed to accommodate up to 50 output channels.

To date, there are only a handful of optical-core switches on the market in limited production. However, the optical switch market is expected to reach $900 million by 2002 and $4.11 billion by 2008. RPI plans to begin commercial production of its photonic switch by Summer 2001. So far, the company has built several thermo-optic switches (which operate on the same principle as electro-optic switches, except that the prism is controlled by heat rather than voltage, and so the switch is slower). In September 2000, the company obtained $18 million in first-round venture funding to start a manufacturing facility for optical networking products. It welcomes inquires from additional investors.

☑ Contact Ron Cowan of Radiant Photonics at (512) 339-0500 or check 3315 on the reader request card.

WEB SITES AND E-MAIL ADDRESSES

The following organizations mentioned in this issue have their own Web sites and/or e-mail addresses for Internet users.

- Advanced Ceramics Research, Inc.
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- Aguila Technologies, Inc.
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WORDS FROM THE WISE

Improving Your… from page 4

3. *Research past successful and unsuccessful proposals in your field.* Find out as much as possible about why they succeeded or failed.

2. *Contact potential investors about Phase II matching funds early if you plan to use the Fast Track program.* Start talking to them at the beginning of the Phase I, and tell them about the timing of your program and investment needs.

1. *Check proposal spellin, punctuation; and grammar.* It ain't trivial!

BMDO Update

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PREVIEW

... and more!

BMDO Update

Learn how BMDO-funded CMOS technology could change the way we view the world.